1.0 What the Assessment Must Include

This section discusses what must be considered and included in the assessment. Section 2.0 prescribes assessment fidelity, describing the care and depth with which each factor must be treated to achieve the needed thoroughness in assessment results. Section 1 and Appendix II-A are both subdivided according to the framework of assessment tasks or modules shown at the bottom of Figure 3. Section II-B.3 is also subdivided this way.

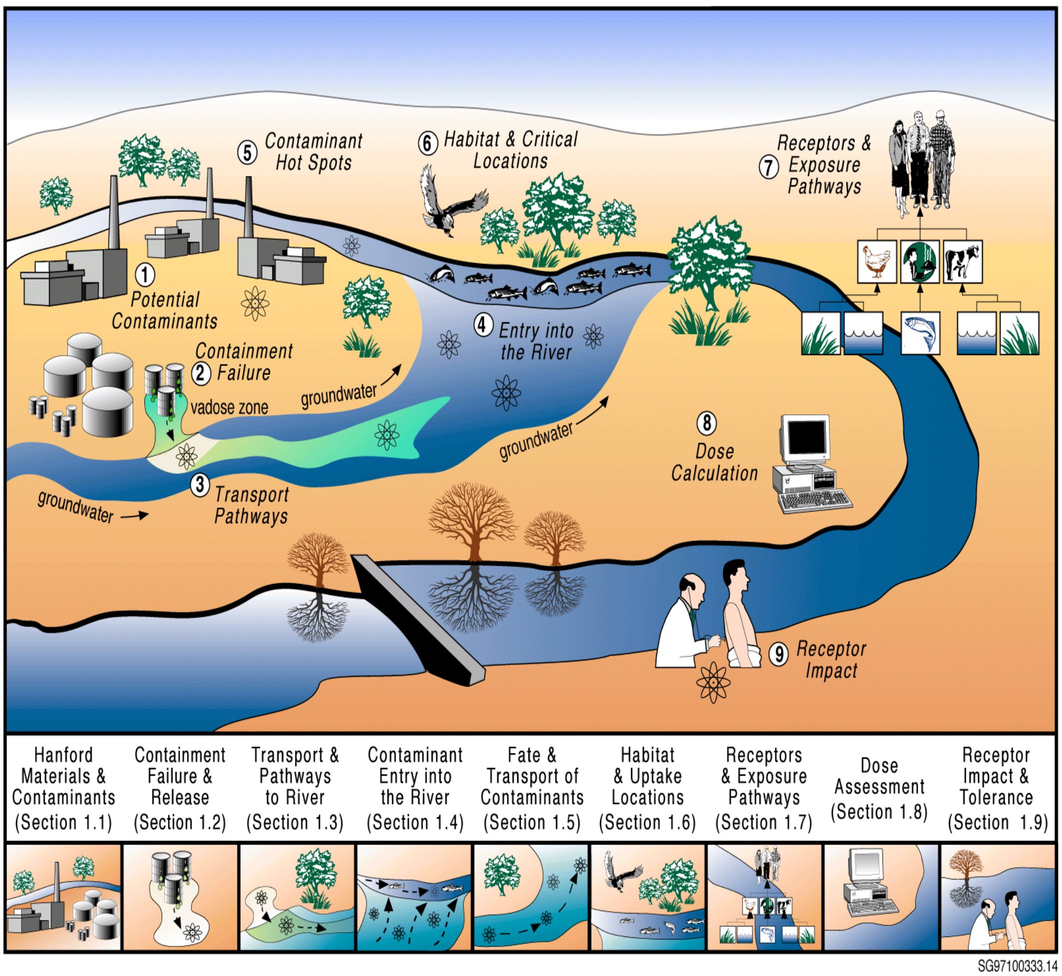


Figure 3. Analysis Modules Comprising the Assessment with Icons as Guides to Related Discussions

The following discussion of these modules, as well as the specific requirements in Appendixes II-A-D, is based on conducting the assessment according to the concept shown in Figure 4. The assessment must meet or exceed all requirements of the Tri-Party Agreement. Any given execution of the assessment process addresses each module shown in Figure 3, maintaining their respective dependencies on one another for valid information. A successive execution of this assessment process is required for each of the socio-economic and climate change scenarios in described Subsection 1.10 below (also see Appendix II-A.10) beginning with the scenario describing today's conditions. It is stressed that the frame of reference is the Hanford Site set of permanent disposal methods planned and approved for the aggregate of all radioactive and chemical materials within the Hanford Site boundary, that is, the Hanford Site post-cleanup end state. This assessment should not make assumptions or otherwise develop this Hanford Site baseline for waste disposal. However, some effort may be needed to compile Ecology, Seimens, and Washington Public Power Supply System data. If interim disposal is planned with no defined permanent disposition, the assessment will regard the interim method as permanent disposal. As the disposal planning baseline changes during the course of the multi-year cleanup effort, the assessment as described above must be updated to determine the impact of the changed disposal plans on the affected people.

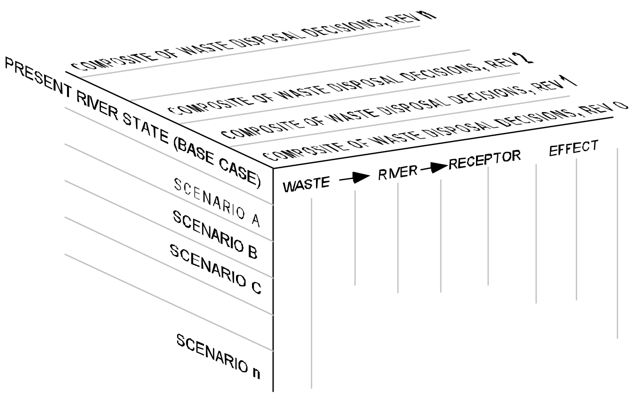


Figure 4. Assessment Concept

Figure 4 summarizes this assessment concept. The right sector of Figure 4 represents the modules shown in Figure 3. Calculations in each module are performed for each scenario shown in the left sector of Figure 4. Assessing risk for all scenarios in this way constitutes one execution of the assessment process. The assessment process is executed for each composite set of Hanford Site-wide waste disposal decisions as shown in the top sector of Figure 4. As that decision set is revised, the assessment must be updated. This assessment should be used to support the decision making process and as a strategic planning tool. In this context, the assessment process becomes a powerful measure of effectiveness for Hanford Site cleanup and overall risk reduction.

CRCIA is complete when the effects on people and other species have been estimated for each scenario and for the Hanford Site composite set of waste disposal decisions as each planned final end state is revised.

1.1 Hanford Materials and Contaminants (Sources and Inventories)

CRCIA addresses all radioactive and chemical materials and wastes within the Hanford Site boundaries. In its source term, it will include information on any potentially harmful chemicals introduced or released as a consequence of remediation work or Hanford operations, including new Hanford Site missions. These combined sources of potential future contamination, called the composite source term, include but are not limited to the sources documented in the DOE-approved Hanford Site listings of special nuclear materials, waste sites, waste discharges, and related databases and documentation. The assessment must use the same source term data as used in DOE's development of the Hanford Site-wide approved remediation and disposal solutions. Failing to maintain this consistency introduces mismatches with DOE's planning base, which may jeopardize the relevance of the assessment's results. If disagreements develop on the usability of DOE's source term information, guidance must be requested from the CRCIA Board. Completeness of the source term information provided for this assessment must be verified to the satisfaction of the CRCIA Board.

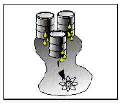
Because the groundwater underlying the Hanford Site is the primary pathway that contaminants are reaching the Columbia River, understanding the contaminant burden potentially to be introduced into Hanford's groundwater from all sources is crucial to this assessment's results. The assessment must include source term information from the Supply System facility, the Ecology low-level waste site, and the Seimens nuclear fuel facility. While these entities are responsible for contaminants originating from their operations, DOE is responsible for determining the cumulative groundwater contaminant load in estimating effects. Chemical and nuclear materials and waste historical background information related to the organizations referenced will be sought.

Materials and wastes continue to arrive at Hanford. These become a part of the composite source term. Information must be obtained to estimate the extent of future shipments to Hanford and their intended disposition. Assessment results will be updated as estimates of future inbound shipments are changed. Permitted discharges to the groundwater and the river must be included in the composite source term.

The composite source term will also include estimates of contaminants that have already escaped containment or are in an indeterminate state, such as buried solid waste. If DOE's approved planning includes remediation work to recover uncontained contaminants, this assessment will treat them as contained materials in their post-remediation state. However, if recovery is not planned, contaminants will be treated as part of the source term already in, or moving to, the groundwater (see Subsection 1.3 below and Appendix II-A.3 for transport requirements).

To help define the source terms, especially estimating uncontained contaminants, the analysts are encouraged to consider chemical mass balance estimating methods. Calculations using known reactor operations data and chemical processing information can help estimate undocumented waste discharges. This approach is also useful in validating source term information (see Appendix II-C.3).

Analysis throughout the assessment will use source term information as available from DOE's characterization work as well as the radioactive decay daughter products commensurate with the long time periods needed for loss of containment, transport to the river, and uptake from the river into and through the pathways to the receptors. Similarly, assessment analyses will include reasonably expected chemical compound breakdown and recombinations into new substances typical with the irrigation, soils, river chemistry, and prevailing agricultural chemicals in the section of the Columbia River being assessed.

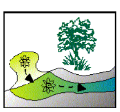


1.2 Containment Failure and Contaminant Release

A primary goal of the Hanford Site cleanup effort is to retrieve, as necessary, and contain radioactive and chemical materials for a period deemed sufficient to ensure safety for the people and organisms who might otherwise be adversely affected by exposure to these materials. Determining the period of containment and rate of contaminant escape is the subject of the requirements in this section.

To maintain the assessment's consistency with the data supporting the Hanford Site waste disposal decisions, the assessment will use the same period of containment and the same estimated leakage rate as used in the disposal decision process, for example, in environmental impact statements. The decision documents usually include strategic planning products, budget proposals, and 5-10 year plans. If information is not available from these preferred sources, performance assessment calculations will be made as a part of this assessment's analysis effort.

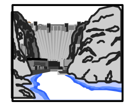
Leakage rate will vary with time as containment deterioration worsens and surrounding soils become more saturated. Because these factors influence eventual contaminant concentrations and effects, these rate estimates must be obtained with good levels of certainty as discussed in Appendix II-C.2.



1.3 Transport Mechanisms and Pathways to the Columbia River

This section addresses requirements concerning two different but related matters. One issue is transport of contaminants downward through the soil to the groundwater beneath the containment device or, if the wastes were not contained, the point of free discharge at the surface. The soil above the groundwater is called the vadose zone. The other issue is the movement of the contaminated groundwater toward the Columbia River. In both cases, travel times, contaminant type, amounts, and concentrations are of great interest. Each will change over a wide range as time passes and as different climate and river characteristics change.

While groundwater is considered the primary pathway by which contaminants reach the Columbia River, other pathways are not to be omitted unless their contribution can be shown to be negligible according to the dominance principle. The assessment is to determine the impact sustained from river and riparian zone contamination regardless of the contaminant pathway to the Columbia River. Section 1.4 addresses the transition of groundwater into river water and points out the importance to the assessment of realizing that in the riparian zone bordering the river contamination can potentially reach wildlife and people in undiluted groundwater.



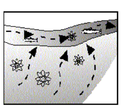
Assessment requirements for vadose zone information include both vertical transport times and estimates of contaminants that have been free within the vadose zone since their initial discharge during reactor operations and chemical processing. In both vadose zone and groundwater contaminant migration estimates, the analyst will consider whether mobility changes could result from chemical modification of the contaminant such that its solubility and sorption characteristics are altered.

Airborne contaminant migration to the Columbia River will also be considered, including airborne deposition on agricultural land which, in turn, is washed into the river by irrigation. Similarly, contaminants from direct discharges to the river will be included.

CRCIA requirements for groundwater movement information include travel times, contaminant presence, quantities, and concentrations. Correlations must be made between the locations of groundwater paths and geographical locations of potential contaminants in surface or vadose containments so the composite groundwater chemistry effects on migration can be estimated.

In determining groundwater total contaminant load, contributions will be included from the Washington Public Power Supply System facility, the Ecology low-level waste site, and the Siemens nuclear fuel facility, even though these entities are environmentally responsible for contaminants from their facilities.

Use of the Hanford Site consolidated groundwater model is encouraged if it is consistent with CRCIA requirements. It is especially important that the groundwater modeling for this assessment be responsive to the principles of balanced management of dominance, uncertainty, and fidelity, as well as being seamlessly compatible with other CRCIA modeling, such as groundwater-to-river water transition models for the riparian zone and contaminant entry into the Columbia River.



1.4 Contaminant Entry into the Columbia River

The requirements in this subject area are especially challenging, principally because of two general considerations. First, groundwater enters the Columbia River in a most irregular, heterogeneous fashion that will be difficult to legitimately generalize. However, failure to explicitly recognize the actual entry locations, volumes, and rates overlooks critical habitat linkages to undiluted, or slightly diluted, potentially contaminated groundwater. An example is the upwelling in the river bottom of groundwater through known salmon spawning beds. River bottom surveys to identify areas of upwelling seem unavoidable. Similarly, surveys of the riparian zone for points where the groundwater comes to the surface are important. Therefore, any modeling assumptions implying an instantaneous, homogeneous entry of groundwater into the main body of the Columbia River are unacceptable for defining local impact.

The second consideration making this a difficult segment of the assessment is that groundwater enters the riparian zones where a large percentage of the river-dependent terrestrial life obtains its water. It is important to understand the relationships between groundwater aquifers beneath the Hanford Site and seeps, springs, wetlands, and free standing surface water in the riparian zone. A spatial description of each plume or point of discharge is also necessary. Overlapping plumes must be evaluated.

The dynamics of river flow patterns, storm run-off, dam operations, and river bank and riparian zone erosion add yet another dimension of difficulty to this assessment task. Field work will likely be needed to provide necessary information, and some approximations will have to be made. Managing the assessment according to the principles of dominance, balanced uncertainty, and fidelity will be especially important in designing and conducting this work.

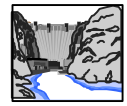
1.5 Fate and Transport of Columbia River-Borne Contaminants

Requirements in this section address modeling how the contaminants mix in the main body of river water. That is, the locations of deposits (fate) of sediment and dissolved contaminants must be determined as well as their redistribution when transported by storms or seasonal changes in river flow. Generalizations that assume instantaneous, homogeneous mixing and dilution, while simplifying the assessment task, are not acceptable because they mask potential linkages between contaminant hot spots and critical river locations such as aquatic habitats and extractions of water for drinking or irrigation. Mixing of groundwater, potentially carrying contaminants, into the main body of the Columbia River is known to be slow and is not complete for perhaps tens of miles downstream from the point of introduction.

These requirements deal primarily with two methods of contaminant transport in the main body of Columbia River water. One is mixing of river water and groundwater potentially contaminated with dissolved radionuclides and chemicals. The other is suspended solids, mostly sediment, some of which have a great affinity for contaminants. Suspended sediment is continually settling, especially where flow rates are low. Sediment settles in holes and quiet water regions of the Columbia River, such as in sloughs and behind large rocks on the river floor. Runoff from storms and seasonal weather changes alters quiet water, sometimes dramatically, and resuspends the sediment, carrying it downstream to more permanent settling spots, perhaps behind dams (especially McNary Dam) or in areas periodically dredged for shipping.

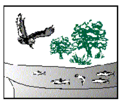
Dissolved contaminants may remain at worrisome concentrations far enough downstream from the point of groundwater influx to encounter municipal water intakes or irrigation water systems. Even at dilute levels, mechanics such as irrigation, water treatment equipment, and hydroelectric turbines provide opportunities for reconcentration of dissolved contaminants. Such opportunities will be identified and evaluated for significance. Locations conducive to sediment accumulation and ecosystem habitats will be evaluated.

For either dissolved contaminants or sediment, little can be realistically concluded about these potential problems without knowledge of the river's flow characteristics, especially groundwater influx points



(addressed in the previous section), turbulent regions, and quiet areas. Columbia River bottom topological mapping surveys will almost certainly be required, as will seasonal changes.

Requirements in this section also deal with chemical recombinations between potential contaminants and the prevailing river chemistry in the area being evaluated. Some synergism of Hanford and offsite contaminants may occur in the Columbia River, causing a greater cumulative impact.



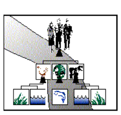
1.6 Critical Habitat and Uptake Locations

This section specifies the requirements for identifying the important locations of plant and animal habitat, for both aquatic and river-dependent terrestrial life, where uptake of contaminants is probable because of the river's deposits discussed in the previous section. Other critical locations, such as municipal water intakes, also must be identified.

Critical locations are defined, for these purposes, as those places where the entry of contaminants into the food chain and other exposure pathways are most likely to occur. This section is especially important to the assessment because the analysis performed here links the contaminant hot spots to the biological/social/economic webs developed in the sections to follow.

The requirements for this subject area in Appendix II-A.6, contain references to the species of interest having been selected and available to help guide the search for habitat and critical locations. A number of the key species can be identified simply on the basis of interest from societal groups and proximity to Hanford and the Columbia River. However, identifying critical locations is very likely to show that certain aquatic and dependent terrestrial species are potentially in harm's way because of their position in the ecosystem web. If their exposure and ensuing impact is found to likely be severe, those species may be added to the species-of-interest list. Selection of the species of interest is the subject of the next section. The search for critical locations should not depend solely on a predetermined set of species to be evaluated.

A point emphasized in these requirements is the necessary search and discovery of habitat located at points of upwelling of undiluted groundwater in the Columbia River. An example is the discovery of active salmon spawning beds in gravels through which chrome-laden groundwater is entering the Columbia River. Similarly, seeps and springs carrying undiluted groundwater to the surface and through the riparian zone into the river need to be identified if those areas contain important habitat or species.



1.7 Receptors and Exposure Pathways

This section contains requirements dealing with the development of exposure web models that realistically define the pathways or mechanisms by which receptors of interest are exposed to contaminants.

Receptors, as defined for this assessment, include humans and human population groups as do other assessments. However, CRCIA goes further to include as a candidate receptor, any species, resource, or environmental function occupying a key juncture in the ecosystem web which, if lost, produces a significant loss or impact to the ecosystem, including potential impact to humans. Selecting all such candidates for the receptors-of-interest list is likely to be impossible until the model of the ecosystem web is complete or the habitat for the candidate species (or its supporting food chain) is found to coincide with a contamination hot spot as discussed above.

CRCIA also includes as receptors those humans and groups projected to suffer any other adverse health effects, including but not limited to, cancer. It is also important to include as species those which by virtue of different cultural life styles may be susceptible to exposures and effects not otherwise encountered. Native Americans and other ethnic or minority life styles, such as migrant farm workers, are in this category. Also included as candidate receptors are river-dependent economic groups such as irrigation supported agriculture, commercial fishing, hydroelectric workers, and river transportation industries (barges and support services like dredging operations).

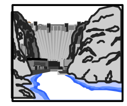
Another important requirement is that receptors in this assessment will include the culture of the affected peoples. If Native Americans, for example, must relocate to avoid untenable exposure from contaminants, this would be considered a serious impact to their culture and their quality of life. If the economy of the Tri-Cities (Richland, Pasco, and Kennewick, Washington) is impacted (for example, by bad water) so as to adversely affect the quality of life of the residents, CRCIA would regard the Tri-Cities culture as a receptor.

Given this perspective, this section requires that both the process for selecting receptors be defined as well as development of models of the related physical, biological, social, cultural, and economic webs of dependency on the Columbia River through which contaminants might reach, and expose the selected receptors over time.

1.8 Dose Assessment

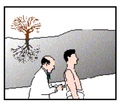
With the selection of receptors to be evaluated and the exposure pathway models developed that relate the receptors to potential sources of contamination, the requirements in this section address the calculation of the dose estimated to be sustained by the receptors. The intent in this section is only to determine dose, that is, level of exposure. Identifying the effects or impact from having received that dose is the subject of the next section.

As a rule, accepted risk assessment practices will guide the analyst in making dose calculations. However, the CRCIA Team expressed several concerns about these accepted practices and the analysts must be responsive to these concerns. For example, unless specific predator and prey feeding habits for a species are unknown and unknowable, calculations must not be overgeneralized. An example is



categorizing animals only by weight and ignoring distinctions in diet, activity patterns, and habitat. Similarly, Native American scenarios will be developed and used as will specialized exposure scenarios for other groups such as farm workers. Aside from the conceptual requirements the reader will find in this section, explicit requirements remain to be developed by the analysts and discussed with the CRCIA Board.

A major point of concern in this area is the exposure that may be sustained in short as well as over long time periods by one or multiple generations. Determining mutagenic effects, which is of great interest, will likely be impossible unless dose calculations are performed with this effect in mind. The analysts will note in this regard that several of the candidate receptors are members of small gene pools that may tend to magnify mutagenic effects.



1.9 Receptor Impact and Tolerance Assessment

The requirements in this section address the effects or impacts expected to be sustained by the species of interest resulting from the exposure calculated in the previous section. Tolerance assessment refers to some impact threshold below which effects to individuals or populations can be tolerated with no unacceptable or irreversible effect. Above such a threshold, unacceptable harm may occur to the individual organism or person, species, group, or culture under study. Without understanding both the impact of the dose received and the level of tolerance to that impact, useful conclusions will be difficult to draw.

Tolerance assessment is one of the key objectives of CRCIA: Evaluate the sustainability of the Columbia River ecosystem, the interrelated quality-of-life, and the viability of socio-economic entities for the period that Hanford materials and contaminants remain intrinsically hazardous. Tolerance assessment applies to total exposure (including background), to additive or synergistic effects from multiple exposures, and to the influence of co-risk factors.

As pointed out earlier, the analyst must be careful not to dismiss as unimportant an effect that may be important from a cultural perspective simply because popular analytical approaches disregard such effects. The seriousness of respecting cultural values can best be illustrated by pointing out that, when in dispute, these matters are settled only through government-to-government negotiations between the sovereign nations of the Native Americans and the U.S. government.

Section II-A.9 requires a number of potential adverse effects to be evaluated to determine if dose levels are expected to be high enough to cause them. However, the analyst is cautioned not to regard this list as exhaustive. The analyst should also expect that unanticipated effects will be identified, or at least inferred, by elevated exposure levels of certain contaminants. The discussion in the “Principles and General Requirements” section also provides guidance in this area.

1.10 Assessment Scenarios: Columbia River, Climate, Geological, and Political Changes

As discussed in Section 1.0 above, the assessment addressed in Sections 1.1 through 1.9 is to be performed for each of several scenarios. Most of the foregoing requirements were written from the perspective of the conditions observed today and accepted as normal. However, the Columbia River, climate, area geology, and even the regional cultural and political conditions change; especially in view of the protracted time scale for which Hanford contaminants remain dangerous, these scenario changes should be expected to be major. The requirements in this section specify that the assessment be performed for changes that can reasonably be expected to occur.

Section II-A.10 lists scenarios in categories generally expected to change pivotal factors in the assessment from what is seen today as normal. For example, a climate change that substantially increases the rainfall in the Hanford area would presumably make a dramatic change in the volume of contaminants reaching the Columbia River as well as the time necessary for them to reach the river. In another example, on a time scale of several hundred or thousands of years, the present dams on the Columbia River would likely be removed, would deteriorate and fail, or at least would have to have major desilting dredging performed. Any of these probabilities would remobilize large accumulations of contaminants in the sediment. Also considering the time scale involved, entirely new governments and/or political structures are inevitable, bringing with them potentially major changes affecting the materials and wastes at Hanford.

In view of the speculative nature of these scenarios and the expense of modifying the assessment for each, a recommended study set of the most credible scenarios must be winnowed from a broader list of candidate scenarios and proposed to the CRCIA Board for approval.

1.11 Hanford Site Disposition Baseline

As Figure 4 shows, CRCIA is to be performed maintaining as much consistency as possible with each set of Hanford Site-wide cleanup/disposal decisions and with each subsequent revision. In other words, for the collection of DOE documents which, at any given time, constitutes the approved Hanford Site post-cleanup end state, there will be a corresponding CRCIA assessment of resultant impact. Because the various documents might be based on different assumptions, they must be compared with those used in CRCIA.

If no officially recognized end-state plan exists for the overall Site, the CRCIA analysts will develop, with DOE's recommendations, the most credible surrogate end-state information available. CRCIA Board approval of such surrogate information is essential.

The analysts must use the characterization of containment package effectiveness (for example, package time to failure and leakage rates) found in approved end-state plan documents. In contrast, however, transport of containment through the vadose zone to the Columbia River, resulting dose levels, and impacts all will be calculated according to CRCIA requirements.